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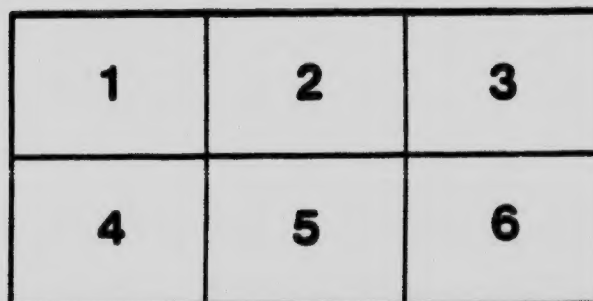
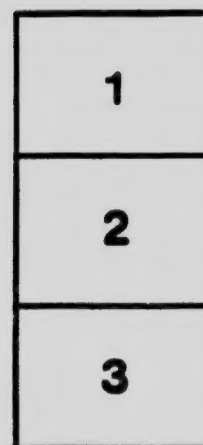
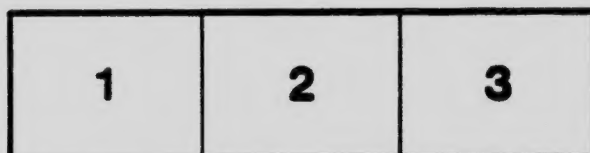
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REPRINTED FROM THE JOURNAL
OF THE ROYAL ASTRONOMI-
CAL SOCIETY OF CANADA,
SEPTEMBER, 1918

THE SOLAR ECLIPSE OF JUNE 8, 1918; OBSERVA-
TIONS AT MATHESON, COLORADO

BY

C. A. CHANT

TORONTO
1918

PLATE IX.



ECLIPSE STATION, MATHESON, COLORADO

Pettit

Chant

Morehouse

Loud



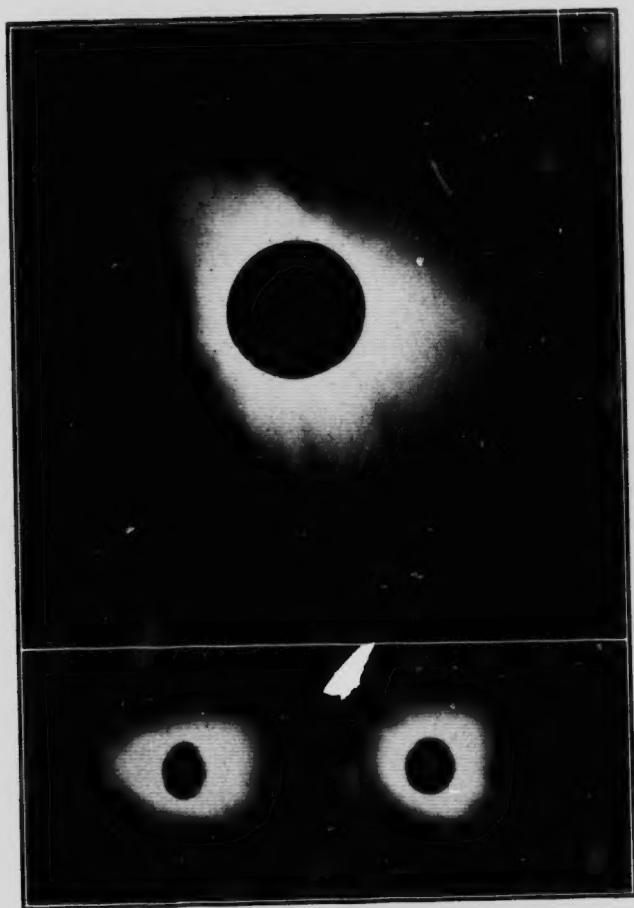
	Chant,	Morehouse,	Pettit,	F. H. Loud,	Hartley,
Whisler,	Neal,	Owens,	Smith,	F. M. Loud,	
Mrs. Whisler,	Miss Gushee,	Miss Steele,			

OBSERVERS AT ECLIPSE STATION, MATHESON, COLO.

Journal of the Royal Astronomical Society of Canada, 1918



PLATE X.



THE CORONA, JUNE 8, 1918

Above: with a 44-inch telescope, exposure 5 sec.

Below: with polariscopic camera. The straight lines show the planes of polarization.

Journal of the Royal Astronomical Society of Canada, 1918

THE SOLAR ECLIPSE OF JUNE 8, 1918; OBSERVATIONS AT MATHESON, COLORADO

By C. A. CHANT

THE path of totality of this eclipse began at sunrise near the island of Borodino, south of Japan, passed east and north across the Pacific Ocean until it neared Alaska, and then, turning somewhat to the south, entered the United States near the mouth of the Columbia River. It crossed the states of Washington, Oregon, Idaho, Wyoming, Colorado, Kansas, Oklahoma, Arkansas, Missouri, Alabama and Florida; and, continuing into the Atlantic Ocean, it left the earth at sunset near the Bahama Islands. At the middle of its course, south of Alaska, at local noon, the duration of the total phase was $2^m 23^s$, and on reaching the coast, at 3.55 "summer" Pacific Time, it was $2^m 1^s$ and the altitude of the sun was 50° . Going farther east, the duration of totality diminished and the altitude decreased, until, on leaving Florida, at 7.42, "summer" Eastern Time, the duration was about 50^s and the altitude about 10° . The entire time required by the shadow to traverse its diagonal path from ocean to ocean was 47 minutes.

For obvious reasons, sites in the far west were chosen for astronomical observations, but afternoon skies in the west in

early June are very uncertain. A party under Director Campbell, of the Lick Observatory, was located near Goldendale, Wash., and after hope of success had almost been abandoned on account of thick clouds, at about a minute before the beginning of the total phase the clouds separated, and so they remained until the entire program had been successfully carried out, when they came together again. At Baker City, Ore., where the U.S. Naval Observatory had a party, observations were made through thin clouds. Farther east, at Green River, Wyo., extensive preparations had been made by the Yerkes and Mt. Wilson Observatories, but one slight cloud somewhat marred the observations. At Rock Springs, Wyo, where Professor Joel Stebbins was stationed, the sky was clear. At Fraser, Colo., were Professor F. P. Leavenworth and Mr. W. O. Beal, of the University of Minnesota Observatory; Professor H. C. Wilson, of Goodsell Observatory, and Mr. J. H. Darling, of Duluth, Minn. The sky was clear at the time of totality. At Denver the sun was completely obscured by clouds, to the great disappointment of a large number of representatives from the Chamberlin, Yerkes and Allegheny Observatories and other places. Sixty miles farther on is Matheson, of which more will be said in what follows. At Brandon, Colo., the joint expedition from the Sproul Observatory, Swarthmore, Pa., and the Kirkwood Observatory, University of Indiana, had a clear sky. Near Syracuse, Kan., the Lowell Observatory expedition had thin clouds. The Smithsonian Astrophysical Observatory had a station between Hartland and Lakin, Kan., and had a clear sky. Dr. Louis Bell, of Boston, was at McAlester, Okla., and reports a moderately clear sky. At Cocoa, Fla., where Professor and Mrs. D. P. Todd were, the sun was obscured by clouds.

Early in the year Professors Frost and Barnard, of the Yerkes Observatory, and Loud, of Colorado Springs, made a tour by motor, searching for suitable sites in Colorado, and one suggested by them was near Matheson, a small village on the Rock Island Railway. In this part of the country at this time of the year the sky, while usually clear in the morning, has

many clouds in the afternoon, especially in the west; but being farther from the mountains than Denver, it was thought that prospects would be better for a clear sky than at that city. The country is rolling, and the summit of a hill, which looked only half a mile away, but which proved to be about two miles west of the village, was chosen as a site for observations and was known as the Colorado College Eclipse Station. Professor Frank H. Loud, lately retired from Colorado College, made preliminary arrangements for the observers.

The geographical coordinates of the site are:

Longitude $6^{\text{h}} 55^{\text{m}} 56^{\text{s}}$ W.

Latitude $39^{\circ} 10'$

Height above sea level, about 6000 feet.

There were four separate installations. The most extensive was that from the Washburn College Observatory, Topeka, Kan., in charge of Professor Edison Pettit, of that institution. He was assisted by Miss Hannah B. Steele, of Yerkes Observatory; Miss Vera M. Gushee, of Smith College Observatory; and Messrs. Finley F. Neal and Roy Owens, of Kansas. The Yerkes Observatory, where Professor Pettit had been acting as assistant for a half year, was also interested in this outfit. In the upper end of a square tube, directed towards that point in the sky to be occupied by the sun at the time of totality, was a lens 12 inches in diameter and of focal length 14 feet. As the lens was to be used for photography, its aperture was stopped down to 4 inches. The lower end of the tube projected into a light-tight house, and the image of the sun was received upon a 10×12 plate moved by clockwork. Attempts were made to obtain some record of the sun's surroundings before and after totality by shielding the plate from the direct sun by placing on the plate a circular object of precisely the same size as the sun's image. Three exposures were made just before and one just after totality. In addition, during totality six exposures, of various lengths, were made and some good negatives were secured.

Besides this, the 'flash' spectrum was photographed with a

single prism with a camera of aperture $1\frac{1}{4}$ inches and focal length 24 inches. Four exposures were also made during the total phase with a telescope of focal length 54 inches and aperture $1\frac{1}{2}$ inches.

Readings of an aneroid barometer were made, by the aid of a magnifier, before, during and after totality. The change, if any, during the eclipse was very small—possibly a minute rise.

A recording thermometer was also included in the equipment; during totality the temperature fell about $3\frac{1}{2}^{\circ}$ F.

Mr. Pettit's party also had a chronometer, which was checked by time signals received at the railway station, and which supplied time for all the observations made at the station.

Another installation was from the Drake University, Des Moines, Ia. Professor D. W. Morehouse, of that institution, had transported his $8\frac{1}{4}$ -inch Brashear refractor, together with a 5-inch photographic doublet, mounted on the tube. With the assistance of Mr. Donald M. Smith, a recent graduate of Drake University, exposures of varying lengths were made simultaneously with these two instruments. The telescope was furnished with two flint-glass components of the object glass, and the instrument was adapted for visual or for photographic use by using one or the other of these. Some excellent negatives were obtained.

The outfit from Colorado College, which is located at Colorado Springs, consisted of three cameras on a single mounting. The objectives of these were as follows:

Cooke anastigmat,	$f = 11$ inches, aperture $f/11$
Cooke anastigmat,	$f = 8$ inches, aperture $f/4.8$
Goerz single anastigmat,	$f = 18$ inches, aperture $f/16$.

The motion in right ascension was produced in a very simple and ingenious manner. Carefully sifted sand, placed in a sheet-metal tank, was allowed to run out through a small hole in the bottom; and as it ran out, a heavy weight placed on the top of it descended slowly and uniformly. To this weight was attached a wire cable, which, after passing over several pulleys, was

wound about the axis to be rotated. The apparatus worked admirably. Mr. Kenneth Hartley assisted Professor Frank H. Loud in handling the apparatus. The object sought was to determine the extreme length of the coronal streamers and to search for any intra-mercurial objects.

My equipment consisted of a 4½-inch Cooke refractor with a photo-visual objective of focal length 81.8 inches; and a polariscopic camera, in which a double-image prism was mounted in front of an objective of aperture 1 inch and focal length 36 inches. The camera was attached to the declination axis of the telescope close to the counter-weight. This apparatus was loaned by the Dominion Astronomical Observatory, Ottawa, and thanks are due to Dr. Otto Klotz, the director, for his cordial assistance. Dr. Klotz and I had been asked by the Council of the Royal Astronomical Society of Canada to observe the eclipse on behalf of the Society. He went to Denver where, as mentioned above, dark clouds covered the sun, but I chose Matheson. I did so because prospects for a clear sky seemed to be as good there as at any place, it appeared to be quite accessible, and also it might be better to go where there would not be so many observers as at stations farther west.

As soon as possible, application was made to the Government at Washington for permission to have the apparatus enter the U.S. free of duty; and after some delay instructions were given to the Collector at Detroit to admit the goods free under bond. They were shipped on Tuesday, May 14, and through the personal interest taken in my expedition by the Agent of the Canadian Express at Toronto and the General Agent of the National Express at Detroit, the boxes containing the instruments went forward without delay and reached Matheson on Sunday, the 19th. Here Professor Loud took charge of them and placed them in safe storage.

I left Toronto on May 31, at 6 p.m. and reached Matheson at 4 p.m. on Sunday, June 2. I found that my boxes had already been taken to the summit of the hill and three small piers for the telescope had been constructed. I had brought oil

cloth to protect the instruments from rain, but was informed that it was even more important to shield them from the wind which at times blew almost a hurricane over the exposed site. However, by good fortune, I obtained the services of two carpenters, one of whom with his own team of horses carted the lumber from the village, and by noon of Monday the shelter was complete. During the afternoon the telescope was unpacked and erected.

On Tuesday afternoon, June 4, Professor Loud, his son Mr. Francis M. Loud and Mr. Hartley arrived with the Colorado College outfit. They had come by motor, a distance of 56 miles. All morning the weather had been fine and the sky a beautiful blue, but soon after their arrival a very violent wind, rain and hail storm broke upon us and lasted for about one and a half hours. It tested our temporary houses but they remained standing.

On Wednesday, Mr. and Mrs. P. F. Whisler, of Jacksonville, Ill., former students of Drake University, joined the party. On that day, as usual, the sky was clear in the morning, but at noon black clouds came up, drops of rain began to fall and I hastily covered my instruments. The dark sky lasted until about 4.30 p.m., when the sun burst forth as brightly as ever, and I was able to complete the adjustment of the instruments.

By Thursday afternoon the arrangement of the apparatus was complete enough for us to rehearse our program. The chronometer was placed on an improvised table in a central position and electrical wires were led to operate signals at each equipment. The proceedings were as follows. Five minutes before the moment for beginning, "Time!" was to be called by Mr. Whisler, and Miss Gushee was to watch for the appearance of the corona. At the instant that she saw it she was to shout, "Go!" and to strike with a hammer on an empty barrel; and immediately Mr. Whisler was to count in a loud voice the seconds as ticked off by the chronometer—one, two, three, until the eclipse was over. In this way each observer could regulate the beginning and the duration of his exposures. As I wished to take photographs both with the tele-

scope and the polariscope, I was glad to accept the offer of Mr. F. M. Loud to assist me. He took charge of the former and I of the latter. During the remaining days our drills were repeated many times until at last we were able to go through the program with precision.

On Friday Mr. Charles C. Plitt, Professor of Botany in the Baltimore City College, Baltimore, Md., joined us. He had come all the way from Baltimore to see the eclipse, having chosen Matheson as the most promising place. At this time, however, our hopes of success were very slight. Day after day, at the time for the total phase, the sky was covered with clouds, especially thick in the west; but learning that Colorado was the despair of the weather forecaster and that the condition of the sky could not be predicted five minutes in advance, we did not give up.

Saturday, the day of the eclipse broke fine, and again our spirits rose, but by noon the ominous cumulus clouds appeared. At 2.30 p.m., "summer" time, they became denser and the sky grew darker. At times great cloud masses entirely obscured the sun. However at 4.13 they thinned out sufficiently for first contact to be seen clearly.

The computations of the times of contact for our station were supplied by Mr. Pettit, as follows:—

Summer Mountain Time			
	h	m	s
First contact	4	13	42.6
Second contact	5	23	50.7 (beginning of totality)
Third contact	5	25	19.2 (end of totality)
Fourth contact	6	28	3.7

The first contact was observed by Messrs. Pettit and Morehouse by projecting upon a sheet of paper the image of the sun as produced by the 3-inch finder of the large refractor. Their observation made it 7.2 later than the computed time. Like many others, I looked for it through smoked glass but I could not detect it until 10s after they had announced it. The other contacts were observed within 1s of the computed times.

Then there was a wait of an hour for the total phase. Many people had come to our station from all directions, perhaps 100 automobiles being gathered on the hill. All continued to watch the thinning solar crescent—and the thickening clouds. During this weary wait we were treated to a novel diversion. A rabbit appeared on the west side of the hill, and to the great amusement of the crowd three men on motorcycles attempted to run it down. The nimble-footed animal circled about for almost ten minutes, and when nearly exhausted ran into a friendly ravine over which the machines could not pass.

At 5.18 "Time!" was called, though the sun could be seen only dimly through the clouds. Soon after this the darkness began to be felt, much as though a great thunderstorm was approaching. But, to our great joy, just as the bright crescent was about to disappear, the clouds parted as though curtains were rolled back, and the sun shone clearly! The 'shadow bands' were very pronounced; through the cracks in our shelter Mr. Loud and I could see them sweeping past. Then Miss Gushee, catching sight of the corona cried "Go!" and Mr. Whisler began to count! There was the silence of awe amongst the on-lookers and the astronomers were busy carrying out their programs. During the exposures we gazed on the corona, but we had to keep a strict account of the passing seconds. At "86" the sunlight shot out from behind the moon and the eclipse was over! Then the crowd surged within the fenced-off enclosure and the hill became alive again.

The corona was clearly seen in all its beauty. At least three great prominences were visible to the naked eye. A great streamer above the sun could be traced for, at least, two solar diameters (say, 2,000,000 miles) while there were two somewhat shorter, though very prominent ones, below. An interesting feature of the eclipse was the sudden appearance of Jupiter which 'popped out' just to the east of the sun as totality was announced.

A photograph of the corona is shown in Plate X. To me the long streamers on opposite limbs seem to indicate not a typical

maximum corona such as seen in 1893 and 1905. From it I would have judged that the maximum had passed by perhaps a year or more, and yet for months before and during the week of the eclipse there were some splendid spots on the sun, and Director Hale in his Annual Report of the Mount Wilson Observatory for 1917, refers to "the prolonged activity of the sun, hardly yet at its maximum."

After totality the clouds promptly returned and they gradually increased in density until at 6.28, the time of the last contact, the position of the sun could hardly be detected at all. Soon after this I began to pack up, and before noon of the following day my boxes were ready for shipment. Although they had made the outward journey in less than six days, they were more than a month in coming back.

As stated above, photographs were made both with the telescope and the polariscope, and the exposures of the former were made to conform to those of the latter, except that one was to be of double length. They were as follows:—

Telescope	Polariscope
5 sec.	5 sec.
46 "	20 "
	20 "
5 "	5 "
6 "	6 "

The rest of the time of the total phase was required to change the plates and films.

With the telescope the 46-sec. exposure was too long and the plate was a failure. The others were successful, though the last one shows a trace of the returning sun. I think the first negative the best.

The photographs with the polariscope were not so successful, though there has not yet been sufficient time to examine them critically. It seemed impossible to obtain a clear sharp image with the instrument.

Professor Plitt observed Bailey's Beads, using the 3-inch finder. They made their appearance six seconds before totality

was called. There were at least 25 visible, and they were yellowish in color.

The 'flash' spectrum was observed by Mr. Donald Smith who reported as follows:—

"The reversal of the Fraunhofer lines was observed at the instant preceding and again at the instant following totality. The bright lines flashed out suddenly and lasted for approximately one second at each of these observations. The lines in the red and the blue-green (probably due to hydrogen) and in the yellow (probably the sodium lines) were most conspicuous. There were a large number of small lines in yellow and yellow-green especially. A faint continuous spectrum served as a background. The instrument used was a small ocular direct-vision spectroscope and the dispersion was not very great."

Mrs. P. F. Whisler observed the Shadow Bands and her statement is as follows:

"Shadow bands were very distinct and plainly visible just before and after the period of totality. They were black and white, each about one inch to one and one-fourth inches in width, and travelled in a direction of north-east and south-west at about a 45° angle. They appeared by the hundreds and passed very rapidly, resembling ripples or waves on water. They passed so rapidly I could not even guess at their number per second. These shadow bands were one of the many beautiful and interesting sights to be observed during the eclipse, and in both instances passed in the same direction and at the same angle. They were visible for a very short period, perhaps two or three seconds on each occurrence."

On one or two evenings during the week Professor Morehouse had allowed visitors to our station to see Saturn, the Cluster in Hercules and other celestial objects. This privilege seemed to be highly valued, and so he announced that if Saturday evening should be clear he would adapt his telescope for visual observations and put it at the service of any one who might come. The evening did become clear—as most of them did by 10 o'clock—and a large number were able to observe

interesting bodies in the sky through this fine instrument. Next day it was dismounted and packed for shipment back to Des Moines.

In concluding this account, I wish to express my gratitude to the Council of the Royal Astronomical Society of Canada for affording me the opportunity to observe this eclipse and to the Governors of the University of Toronto for contributing to the cost of transporting and erecting my instruments.